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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/593,809	06/28/2007	Jagdish Narayan	13194-00048-US	4923

23416 7590 06/30/2010

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EXAMINER	
LANGMAN, JONATHAN C	

ART UNIT	PAPER NUMBER
1784	

MAIL DATE	DELIVERY MODE
06/30/2010	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/593,809	NARAYAN ET AL.	
	Examiner	Art Unit	
	JONATHAN C. LANGMAN	1784	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *10 May 2010*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *29-41* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *29-41* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on May 10, 2010 has been entered.

Claim Rejections - 35 USC § 112

The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claims 29-38 and 40 are rejected under 35 U.S.C. 112, first paragraph, because the specification, while being enabling for a film on a substrate, does not reasonably provide enablement for a free standing film. The specification does not enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to produce the invention commensurate in scope with these claims.

Claims 29 and 34 are directed to a free standing, self supported tantalum film (i.e. the instant claims do not set forth a substrate or underlying structure). However the specification does not enable a person of skilled in the art to produce the free standing self supported tantalum films instantly claimed. The specification is directed

towards coating substrates with a tantalum film, however, the specification does not teach how to prepare self-supporting tantalum films.

Regarding claims 29 and 38, applicant claims a tantalum film that has single crystal microstructure and no grain boundaries. The examiner can not find and the applicant has not shown support for a single crystal tantalum film with no grain boundaries. The applicant defines "single crystal" at page 7, lines 1-7 of the originally filed specification. The applicant states "single crystal" refers to a tantalum film, characterized by an absence of **large-angle** crystal boundaries, and includes a material without large angle boundaries, wherein the term also includes enlarged crystals.

The applicant then described how to achieve these "single crystal" tantalum films, but never discloses a working example with single crystal films with no grain boundaries. Although applicant discloses on page 2, lines 23-36 that "single crystal alpha-Ta layers remain stable with temperature due to absence of grain boundaries and its high melting point...". This teaching of a single crystal film is in the background section of the specification, and does not show support for the instant Ta films to have no grain boundaries.

Claims 30-33, 35-37 and 40 are rejected for being dependent upon base rejected claims.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 29-33 are rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Marcus ("Electrical and Structural Properties of Epitaxial bcc Tantalum Films").

Regarding claims 29 and 30, Marcus et al. teach thin films of epitaxial single crystal films of tantalum formed on a substrate. The tantalum films are body centered cubic (bcc) and have a resistivity of 16 micro ohm–cm, indicative of alpha phase tantalum (title, abstract and "introduction" section). Marcus teaches that electron diffraction patterns were obtained and only single crystal diffraction patterns were observed, thus the film is said to have characteristic (100) spot diffraction patterns, as instantly claimed (pg 3122, col. 2). Marcus goes on to teach that quenching from a high temperature results in a smooth single crystal film, with only dislocations present (i.e. no grain boundaries are present) ("summary" section, pg 3127).

Marcus is silent to the tantalum film being characterized by an X-ray diffraction peak at two theta = 55^{o}. However this characteristic is inherent to the single crystal tantalum film of Marcus since it has been held that similar materials possess similar properties and characteristics. Where the claimed and prior art products are produced by identical or substantially identical processes, the Patent and Trademark Office can require an applicant to prove that the prior art products do not necessarily or inherently possess the characteristics of the claimed product. Whether the rejection is based on "inherency" under 35 U.S.C. § 102, or "prima facie obviousness" under 35 U.S.C. § 103,

jointly or alternatively, the burden of proof is the same, and its fairness is evidenced by the inability of the Patent and Trademark Office to manufacture products or obtain and compare prior art products. *In re Best,* 562 F.2d 1252, 1255 (CCPA 1977).

The mere recitation of a newly discovered property, inherently possessed by things in the prior art, does not cause a claim drawn to those things to distinguish over the prior art. In re Swinehart, 439 F.2d 210, 212-13 (CCPA 1971). In the present case Marcus discloses single crystal tantalum films with the same resistivities, same diffraction characteristics, and same cubic structure; therefore it is the Examiner's position that the instantly claimed x-ray diffraction peak is present in the film of Marcus, since the film of Marcus has the same structure and the same characteristics as instantly claimed.

Regarding claims 31, as seen in Table 1, the room temperature resistivity is varied between 15 and 30 micro ohms-cm dependent upon the deposition temperature (pg 3124).

Regarding claims 32 and 33, the applicant never positively recites that copper must be present in the film. The claim sets forth that the film has a net diffusion distance of less than 10 nms after annealing with copper at a temperature between 650-750°C for one hour. This limitation is an end effective result, where "if" the film is annealed it will possess these characteristics. Even though Marcus does not teach this characteristic, it is expected that the instantly claimed characteristics of net diffusion will be present in the film of Marcus et al. when annealed with copper, since, as shown above, the films of Marcus are the same as those presently claimed.

Claims 34-37, 39, and 41 are rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Ding et al. (US 6,057,237).

Ding et al. teach a silicon substrate (col. 1, lines 18-22), upon which is deposited a silicon oxide dielectric. Within a trench opening in the dielectric, alternating layers of amorphous tantalum and amorphous tantalum nitride are formed (col. 2, lines 30-45). The tantalum nitride can be formed as the first layer followed by a tantalum thereon (col. 2, lines 50-53). The deposition results in a wholly amorphous multilayer stack of alternating layers of TaN and Ta (col. 3, lines 4). A copper layer is formed thereon and the amorphous barrier layer prevents diffusion of copper into an adjacent dielectric material (col. 1, lines 54-61 and col. 3, lines 4-10). A dense, wholly amorphous layer, will inherently have no grain boundaries.

Ding et al. are silent to a diffuse ring in the electron diffusion pattern as well as a diffuse x-ray diffraction peak at two theta = 30-35°, however these characteristics are inherent to amorphous tantalum films. Where the claimed and prior art products are produced by identical or substantially identical processes, the Patent and Trademark Office can require an applicant to prove that the prior art products do not necessarily or inherently possess the characteristics of the claimed product. Whether the rejection is based on "inherency" under 35 U.S.C. § 102, or "prima facie obviousness" under 35 U.S.C. § 103, jointly or alternatively, the burden of proof is the same, and its fairness is

evidenced by the inability of the Patent and Trademark Office to manufacture products or obtain and compare prior art products. *In re Best*, 562 F.2d 1252, 1255 (CCPA 1977).

The mere recitation of a newly discovered property, inherently possessed by things in the prior art, does not cause a claim drawn to those things to distinguish over the prior art. In re Swinehart, 439 F.2d 210, 212-13 (CCPA 1971).

Since Ding et al. teaches the same amorphous tantalum film as instantly claimed, it is expected that it will possess the same material characteristics, i.e. x-ray diffraction pattern and diffuse ring.

Regarding claims 36 and 37, Ding et al. are silent to the net diffusion characteristics of the annealed structure, however, if the structure of Ding were annealed at 650-750°C for one hour, the film would inherently possess a net diffusion distance of less than 10 nms, as instantly claimed, as it has been held that similar materials will yield similar results (see in re best case law applied above).

Regarding claims 35 and 37, Ding et al. are silent to the resistivity of the tantalum, film, however, the discrete layer of amorphous tantalum, is expected to have the same resistivity instantly claimed (i.e. 250-275 micro ohm-cm), as a material and its properties are inseparable (see in re best case law applied above).

Claim 38 is rejected under 35 U.S.C. 103(a) as being unpatentable over Stavrev et al. (Behavior of thin Ta-Based films in the Copper/barrier/Si system) in view of Menzel et al. (US 4,372,989).

Stavrev et al. teach methods of making an ideal diffusion barrier system between copper and silicon. Stavrev et al. teach that the barrier performance realies upon the grain boundaries, and teaches that nanocrystalline, amorphous, and single crystal tantalum films would provide the highest amount of barrier performance (see figure 2, and discussion on page 994). Stavrev et al. go on to teach methods of achieving amorphous and nanocrystalline tantalum films (Table 1, pg. 995, and abstract), but fail to teach a specific example employing single crystal tantalum films.

Menzel et al. teach forming monocrystalline tantalum films on silicon substrates (abstract and examples 1 and 2 (col's 4 and 5)).

It would have been obvious to use single crystal films of tantalum as taught by Menzel, as obvious alternatives to the disclosed amorphous and nanocrystalline films of Stavrev, as Stavrev teaches that these single crystal tantalum films will have similar barrier performances.

Although, Menzel does not teach that the single crystal tantalum film has a x-ray diffraction peak at two theta = 55° and characteristic (100) spot diffraction pattern and having no grain boundaries, these characteristics are all inherent to single crystal tantalum films, and are intrinsically present within the single crystal film of Menzel. (See in re best case law applied above).

Claim 40 is rejected under 35 U.S.C. 103(a) as being unpatentable over Stavrev et al. (Behavior of thin Ta-Based films in the Copper/barrier/Si system) in view of

Menzel et al. (US 4,372,989), as applied to claim 38 above, in view of Woo et al. (US 6,531,780).

As described above, Stavrev modified by Menzel et al. teach a silicon substrate upon which is deposited a single crystal tantalum barrier layer, upon which is deposited a copper metallization. Stavrev and Menzel fail to teach forming a TiN or TaN layer in between the silicon substrate and the tantalum layer.

Woo et al. teach semiconductor devices comprising barrier layers of tantalum for copper metallizations (col. 4, lines 50-55, and col. 6, lines 7-15). Woo go on to teach that tantalum nitride and titanium nitride may be used as adhesion layers between the tantalum barrier layers and the silicon semiconductor substrate (col. 2, lines 58-60; col. 4, lines 25-40; and col. 6, lines 7-15).

It would have been obvious to insert tantalum nitride or titanium nitride between the tantalum layers and the silicon substrate of Stavrev modified by Menzel et al., as Woo et al. has shown that these nitride layers are known in the art to provide better adhesion for tantalum diffusion layers.

Response to Arguments

Applicant's arguments with respect to claims 29-41 have been considered but are moot in view of the new ground(s) of rejection.

On page 8, lines 4-8, applicant states that while nanocrystalline, single crystal, and amorphous Ta films have previously been hypothesized to exist, they have never before been proven with analytical methods such as x-ray diffraction.

As has been shown by the applied prior art above, amorphous and single crystal Tantalum films are known in the art. Even though these films have never been characterized by x-ray, the mere recitation of a newly discovered property, inherently possessed by things in the prior art, does not cause a claim drawn to those things to distinguish over the prior art. In re Swinehart, 439 F.2d 210, 212-13 (CCPA 1971).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to JONATHAN C. LANGMAN whose telephone number is (571)272-4811. The examiner can normally be reached on Mon-Thurs 8:00 am - 6:30 pm EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jennifer McNeil can be reached on 571-272-1540. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

JCL

/Timothy M. Speer/
Primary Examiner, Art Unit 1784